CLAIMS

1. An aggregate composition comprising:

a plurality of polymer molecules, each polymer molecule, prior to aggregation, comprising at least 7 monomer units or having a molecular weight of at least 7000 g/mol, having a fluorescence quantum yield of at least 2%, being electrically conductive or semiconductive, and having electrical properties such that electronic interactions extend at least 2 monomer units from their source such that a spectral comparison of one of the monomer units to the polymer molecule comprising such unit demonstrates a change in gap between the highest filled molecular or electronic orbital and the lowest unfilled molecular or electronic orbital of the monomer unit versus the polymer molecule of at least 0.1 eV,

the aggregate comprising the polymer molecules arranged in a non-aligned, electronically-communicative manner providing a fluorescence quantum yield for the aggregate at least 0.05 times that of the individual quantum yields of the polymer molecules, an absorption spectrum having a unique, red-shifted absorption relative to an absorption spectrum of a random dispersion of the polymer molecules, and being stable in the absence of solvent for at least one minute in air at no less than 50 degrees Celsius, as indicated by a change in quantum yield of no greater than 5% and a change in wavelength of the unique absorption of no more than 5%.

2. The aggregate composition of claim 1, wherein the polymer molecules are arranged in a manner providing a fluorescence quantum yield for the aggregate at least 0.30 times that of the individual quantum yields of the polymer molecules.

3. The aggregate composition of claim 1, wherein the polymer molecules are arranged in a manner providing a fluorescence quantum yield for the aggregate at least 0.60 times that of the individual quantum yields of the polymer molecules.

4. The aggregate composition of claim 1, wherein each polymer molecule has molecular weight of at least about 12000 g/mol.

5. The aggregate composition of claim 1, wherein each polymer molecule comprises a backbone chain of atoms.

6. The aggregate composition of claim 5, wherein the backbone chain comprises an element selected from the group consisting of carbon, nitrogen, boron, silicon, and germanium.

7. The aggregate composition of claim 5, wherein the backbone chain consists essentially of carbon.

8. The aggregate composition of claim 5, wherein the backbone chain consists essentially of silicon.

9. The aggregate composition of claim 5, wherein each polymer molecule has a persistence of at least about 15 nm.

10. The aggregate composition of claim 1, wherein the aggregate composition is chiral.

11. The aggregate composition of claim 1, wherein the aggregate composition is stable in the absence of solvent for at least one minute in air at no less than 75 deg. C.

12. The aggregate composition of claim 1, wherein the aggregate composition is stable in the absence of solvent for at least one minute in air at no less than 100 deg. C.

13. The aggregate composition of claim 1, wherein the aggregate composition is stable in the absence of solvent for at least about one hour in air.

14. The aggregate composition of claim 1, wherein the aggregate composition is stable in the absence of solvent for at least about one day in air.

15. The aggregate composition of claim 1, wherein the aggregate composition is stable in the absence of solvent for at least about seven days in air.

16. The aggregate composition of claim 1, wherein the aggregate composition is stable in the absence of solvent for at least about thirty days in air.

17. The aggregate composition of claim 1, wherein the aggregate composition is stable in the absence of solvent for at least about 180 days in air.

18. The aggregate composition of claim 1, wherein the aggregate composition is stable in the presence of solvent.

19. The aggregate composition of claim 1, wherein the aggregate composition is a nanoparticle.

20. The aggregate composition of claim 1, wherein the aggregate composition is a colloid.

21. A system comprising the aggregate composition of claim 1, and further comprising a photodetector in optical communication with the aggregate.

22. A diode comprising the aggregate composition of claim 1.

23. A system comprising the aggregate composition of claim 1, and further comprising an electrode able to collect electrons from the aggregate.

24. A photovoltaic device constructed and arranged to convert electromagnetic energy into electrical energy comprising the aggregate composition of claim 1.

25. The aggregate composition of claim 1, further comprising a binding site for a chemical or biological molecule.

26. The aggregate composition of claim 1, wherein the aggregate composition is able to emit circularly polarized light.

27. A sensor comprising the aggregate composition of claim 1, wherein the sensor is able to detect an enantiomeric excess of a molecule in solution.

28. The aggregate composition of claim 1, wherein at least one polymer molecule comprises an aromatic ring.

29. The aggregate composition of claim 1, wherein a fused multicyclic ring structure of at least one polymer molecule produces a three dimensional shape by preventing portions of the polymer molecule from rotating.

30. The aggregate composition of claim 1, wherein at least one polymer molecule comprises a feature able to prevent linearization with a second polymer molecule.

31. The aggregate composition of claim 30, wherein the feature physically prevents linearization.

32. The aggregate composition of claim 31, wherein the feature comprises an iptycene moiety.

33. The aggregate composition of claim 31, wherein the feature comprises a first group and a second group attached to the polymer molecule, the first group having a first fixed height above a plane containing a backbone chain of the polymer and the second group having a second fixed height below the plane, wherein a sum of the first fixed height and second fixed height is at least about 0.45 nanometers.

34. The aggregate composition of claim 31, wherein the feature is chiral.

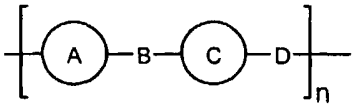
35. The aggregate composition of claim 31, wherein the feature is shape-persistent.

36. The aggregate composition of claim 30, wherein the feature chemically prevents linearization.

37. The aggregate composition of claim 36, wherein the feature chemically immobilizes the at least one polymer molecule to the second polymer molecule.

38. The aggregate composition of claim 37, wherein the feature chemically immobilizes the at least one polymer molecule to the second polymer molecule via a reaction selected from the group consisting of a free radical polymerization reaction, a metathesis reaction, a 2+2 photocycloaddition reaction, an epoxides ring opening reaction, a condensation reaction, hydrogen bonding, a Diels-Alder cycloaddition reaction, a protein-protein interaction, an interaction between nucleotides, an electrostatic interaction, a metal-ligand interaction, a ligand receptor-interaction and a self-complementary molecular recognition.

39. The aggregate composition of claim 1, wherein at least one polymer molecule comprises a polymer comprising a structure:



wherein n is at least 1, A and C each comprise an aromatic group, and B and D are selected from the group consisting of a double bond and a triple bond.

40. The aggregate composition of claim 39, wherein at least one of A and C comprises a halogen atom.

41. The aggregate composition of claim 39, wherein at least one of A and C comprises an iptycene moiety.

42. The aggregate composition of claim 1, wherein the aggregate composition comprises a crosslinked network structure .

43. The aggregate composition of claim 1, wherein at least some of the polymer molecules are physically intertwined in superhelix bundles within the aggregate.

44. The aggregate composition of claim 1, wherein at least one polymer molecule comprises an iptycene moiety.

45. The aggregate composition of claim 1, wherein the polymer molecules are ordered in a substantially regular arrangement.

46. The aggregate composition of claim 45, wherein the substantially regular arrangement is incapable of relaxing to form an amorphous arrangement.

47. A method comprising:

synthesizing the aggregate composition of claim 1.

48. The method of claim 47, wherein the aggregate composition is formed upon addition of a non-solvent to the polymer molecules.

49. The aggregate composition of claim 1, wherein the fluorescence quantum yield of the plurality of polymer molecules is at least 5%.

50. The aggregate composition of claim 1, wherein the fluorescence quantum yield of the plurality of polymer molecules is at least 20%.

51. An organic light emitting device comprising the aggregate composition of claim 1.

52. A sensor comprising the aggregate composition of claim 1.

53. The sensor of claim 52, wherein the sensor is a chemical sensor.

54. The sensor of claim 52, wherein the sensor is a biological sensor.

55. The sensor of claim 52, wherein at least one polymer molecule includes a chromophore, the aggregate composition being capable of emitting radiation with a

quantum yield of at least about 0.05 times that of a quantum yield of the polymer in solution.

56. An explosives sensor comprising the aggregate composition of claim 1.

57. A photodetector comprising the aggregate composition of claim1.

58. The aggregate composition of claim 1, wherein at least one polymer molecule comprises a polymer comprising a structure:

$[AW]_n$,

wherein n is at least 1, A is a bicyclic moiety, W is a cyclic moiety, and A and W are fused.

59. The aggregate composition of claim 58, wherein W comprises a structure:

XY_m,

where m is at least 1, X is a cyclic moiety and Y is a substituent bonded to X.

60. The aggregate composition of claim 58, wherein W is unsaturated.

61. The aggregate composition of claim 58, wherein W is aromatic.

62. The aggregate composition of claim 58, wherein W is heterocyclic.

63. The aggregate composition of claim 58, wherein W comprises a benzene ring.

64. The aggregate composition of claim 58, wherein W is chiral.

65. The aggregate composition of claim 59, wherein Y is chiral.

66. The aggregate composition of claim 58, wherein A comprises a [2.2.2] bicyclic ring system.

67. The aggregate composition of claim 58, wherein A comprises a [2.2.1] bicyclic ring system.

68. The aggregate composition of claim 58, wherein A comprises a [2.1.1] bicyclic ring system.

69. The aggregate composition of claim 58, wherein A comprises oxygen.

70. The aggregate composition of claim 58, wherein A comprises nitrogen.

71. The aggregate composition of claim 1, wherein at least one polymer molecule comprises a polymer comprising a structure:

$[AWB]_n$,

wherein n is at least 1, at least one of A and B is a bicyclic moiety, W is a cyclic moiety, and A and W are fused.

72. The aggregate composition of claim 71, wherein A and B are each bicyclic moieties.

73. The aggregate composition of claim 71, wherein A and B are independently selected.

74. The aggregate composition of claim 71, wherein W comprises a structure:

XY_m,

where m is at least 1, X is a cyclic moiety and Y is a substituent bonded to X.

75. The aggregate composition of claim 71, wherein W is unsaturated.

76. The aggregate composition of claim 71, wherein W is aromatic.

77. The aggregate composition of claim 71, wherein W is heterocyclic.

78. The aggregate composition of claim 71, wherein W comprises a benzene ring.

79. The aggregate composition of claim 71, wherein W is chiral.

80. The aggregate composition of claim 74, wherein Y is chiral.

81. The aggregate composition of claim 71, wherein at least one of A and B comprises a [2.2.2] bicyclic ring system.

82. The aggregate composition of claim 71, wherein at least one of A and B comprises a [2.2.1] bicyclic ring system.

83. The aggregate composition of claim 71, wherein at least one of A and B comprises a [2.1.1] bicyclic ring system.

84. The aggregate composition of claim 71, wherein A comprises oxygen.

85. The aggregate composition of claim 71, wherein A comprises nitrogen.

86. The aggregate composition of claim 1, wherein at least one polymer molecule comprises a polymer comprising a structure:

$[W]_n$,

wherein n is at least 1 and W is a cyclic moiety.

87. The aggregate composition of claim 1, wherein W comprises a cyclopentyl ring.

88. The aggregate composition of claim 86, wherein W comprises a structure:

XY_m,

where m is at least 1, X is a cyclic compound and Y is a substituent bonded to X.

89. The aggregate composition of claim 88, wherein Y comprises a benzene ring.

90. The aggregate composition of claim 88, wherein Y comprises at least two benzene rings.

91. The aggregate composition of claim 86, wherein W is unsaturated.

92. The aggregate composition of claim 86, wherein W is aromatic.

93. The aggregate composition of claim 86, wherein W is heterocyclic.

94. The aggregate composition of claim 86, wherein W comprises a benzene ring.

95. The aggregate composition of claim 86, wherein W is chiral.

96. The aggregate composition of claim 88, wherein Y is chiral.

97. A method for amplifying an emission, comprising:

providing an article comprising the aggregate composition of claim 1, the aggregate composition comprising a polymer having an energy migration pathway and a chromophore;

exposing the article to a source of energy to form an excitation energy; and

allowing the excitation energy to travel through the migration pathway and to transfer to the chromophore, causing an emission that is greater than an emission resulting from a polymer free of an energy migration pathway.

98. A method for amplifying an emission, comprising:

providing an article comprising the aggregate composition of claim 1, the aggregate composition comprising a polymer having an energy migration pathway, the polymer having reduced pi-stacking;

exposing the article to a source of energy to form an excitation energy; and

allowing the excitation energy to travel through the migration pathway to cause an emission that is greater than an emission resulting from a polymer free of an energy migration pathway.

99. A sensor, comprising:

an article comprising the aggregate composition of claim 1, the aggregate composition comprising a polymeric composition and a chromophore, the article further comprising an activation site wherein the chromophore is capable of activation by an analyte at the activation site; and

an energy migration pathway within the polymeric composition, wherein energy can be transferred between the pathway and the activation site.

100. A sensor comprising the aggregate composition of claim 1, wherein the aggregate composition is capable of emission, and wherein the emission is variable and sensitive to a dielectric constant of a medium surrounding the sensor.

101. A sensor comprising the aggregate composition of claim 1, wherein the aggregate composition capable of emission, and wherein the emission is variable and sensitive to an electric field of a medium surrounding the sensor.

102. An amplification device, comprising:

the aggregate composition of claim 1, the aggregate composition having an energy migration pathway capable of transporting an excitation energy; and

a chromophore in electronic communication with the energy migration pathway, the chromophore being capable of emitting an enhanced radiation.

103. A polymeric composition, comprising:

the aggregate composition of claim 1, the aggregate composition comprising a polymer having a conjugated pi-backbone, the pi-backbone comprising a plane of atoms, a first group and a second group attached to the pi-backbone, the first group having a first fixed height above the plane and the second group having a second fixed height below the plane wherein a sum of the first and second heights is at least about 4.5 Å.